Portland West Quadrangle, Maine

Bedrock geologic mapping by
Arthur M. Hussey II

Digital cartography by:
Robert A. Johnston

Robert G. Marvinney
State Geologist

Cartographic design and editing by:
Robert D. Tucker

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Maine Geological Survey

Address: 22 State House Station, Augusta, Maine 04333
Telephone: 207-287-2801 **E-mail:** mgs@maine.gov
Home page: http://www.maine.gov/doc/nrimc/nrimc.htm

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On the geologic map, different bedrock units are indicated by colors and identified by letter symbols that represent their assigned age and unit name. The following description summarizes the major rock types of each unit and gives a simplified geologic history by which they formed.

MAJOR ROCK TYPES

The stratified, or layered, rocks of the Portland West quadrangle are all metamorphic rocks, including schist, phyllite, gneiss, granofels, and amphibolite. Schist consists mostly of thin, flat flakes of mica which are arranged parallel to each other such that the rock splits into sheets. Phyllite has a similar mineral texture except the individual grains are very small and not readily seen without a microscope. Gneiss is a type of layered rock in which the different minerals are concentrated in separate, irregular streaks or layers. Granofels, made up primarily of the minerals quartz and feldspar, has a grainy texure somewhat like sugar. In contrast with schist and phyllite, gneiss and granofels tend to break into angular blocks or chunks. Amphibolite is a rock named for dark grains of the mineral amphibole, the principal constituent of the rock. Varieties of gneiss, schist, and granofels may be further distinguished by their particular mineral content, grain size, color, or other characteristics.

ORIGIN OF THE STRATIFIED ROCKS

The oldest rocks of the Portland West quadrangle, southeast of the Johns Point fault, belong to the Casco Bay Group, a diverse assortment of metamorphosed volcanic rocks, shales, and limestone, deposited during Ordovician time (see Geologic Time Scale, below). The oldest unit of the Casco Bay Group is the Cushing Formation, a thick pile of light gray volcanic material, composed of coarse angular blocks of volcanic breccia and fine volcanic ash with crystals of quartz and feldspar. This formation is not exposed in the Portland West quadrangle, but is well exposed along the shore in the vicinity of Portland Head Light in the adjacent Portland East quadrangle. These rocks formed as hot lava erupted on an ancient ocean floor and became fragmented upon contact with the cold ocean water. As volcanic activity ended, shale and siltstone of the Cape Elizabeth Formation (Photo 1) accumulated conformably on top of the volcanic pile. A period of renewed submarine volcanism ensued, depositing basaltic and andesitic ash and breccia of the Spring Point Formation (Photo 2). In places, black shale of the Diamond Island Formation (Photo 3), rich in organic matter and iron sulfide, accumulated after cessation of the basaltic volcanism. This was followed by accumulation of more shale and siltstone, of the Scarboro and Jewell Formations, and shaly limestone of the Spurwink Metalimestone

The Merrimack Group is represented in the Portland West quadrangle by the Eliot and Berwick Formations, a sequence of metamorphosed calcareous siltstone and shale. The best exposures of the Eliot Formation occur in the area of Exit 7A of the Maine Turnpike in South Portland. Here the formation consists of thin-bedded, highly sheared alternations of light buff-gray calcareous metasiltstone and dark gray phyllite (Photo 4). Across the Fore River in Portland, these same rocks have been metamorphosed to higher temperature, producing green amphibole and epidote in the calcareous rocks (Photo 5). Rocks assigned to the Berwick Formation occupy the largest part of the Portland West quadrangle. These rocks are are brownish gray granofels with interbeds of greenish gray gneiss and granofels (Photos 6 and 7). They are hard, making them suitable for durable rock aggregate such as is produced at the Blue Rock Quarry (Photo 8) between Portland and Westbrook. Rocks of both the Eliot and Berwick Formations are interpreted to be deep ocean sediments deposited during Late Ordovician to Early Silurian time.

The Central Maine sequence, deposited during Late Ordovician to Early Silurian time, consists of highly metamorphosed calcareous and non-calcareous sandstone and siltstone of the Hutchins Corner Formation. These rocks were extensively injected by magma, now preserved as conformable layers of light-colored granite and pegmatite. The Hutchins Corner Formation is correlated with the Berwick Formation of the Merrimack Group.

DEFORMATION, METAMORPHISM, FAULTING, AND IGNEOUS INTRUSION

Rocks of all the stratified sequences were complexly folded during a period of major regional deformation known as the Acadian orogeny, in Early to Middle Devonian time. Large-scale deformation of the Earth's crust is indicated by large folds in the map pattern and cross-sections. During late stages of this active deformation period, the rocks were forced to deep levels in the Earth's crust where heat and pressure gradually transformed the sedimentary rocks into the metamorphic rocks that we see now. Shale was transformed into phyllite and schist; sandstone and silstone became granofels and gneiss; volcanic ash and breccia of basaltic composition became amphibolite. The intensity of metamorphism was not everywhere the same. Some rocks became hot enough to melt, yielding granitic magma that was injected into the metamorphic rocks forming the large body of granite in the northwestern quarter of the Portland West quadrangle (Photo 9) and lens-shaped bodies in the northern part of the City of Portland (Photo 10). Some of the magma was injected in cross-cutting cracks and cooled to form dikes of a very coarse-grained granite known as pegmatite (Photo 11).

After the Acadian orogeny the rocks of the quadrangle were subjected to major faulting and shearing while still deep in the Earth's crust (Photo 12), forming part of the Norumbega fault zone. Shear bands, disrupted white quartz veins, and many similar small structures that formed during this event attest to the fact that rocks sheared past each other in a right-lateral sense; i.e., rocks on the east moved south and rocks on the west moved north. This ancient fault zone in some ways resembles the present-day San Andreas fault in California. Later faulting, with vertical rather than sideways motion, formed the major normal faults of the quadrangle, the Fore River, South Portland, and Flying Point faults.

The youngest rocks in the area are the numerous dark-colored basalt and diabase dikes. They formed when basaltic magma was injected into extensional fractures produced during continental rifting of the incipient Atlantic Ocean in Mesozoic time. These widely-scattered dikes are typically a few inches to a few feet thick. The present landscape and ocean bathymetry are fundamentally controlled by uneven erosion of the complex underlying bedrock geology over great spans of time, modified by recent and ongoing surface processes.

Photo 1. Dark gray garnet phyllite of the Cape Elizabeth Formation, exposed in small rock quarry in the Thornton Heights area of South Portland, just south of Long Creek.

Photo 2. Metamorphosed andesitic ash of the Spring Point Formation exposed beneath the on-ramp for the Casco Bay Bridge, Portland.

Photo 3. Black phyllite of the Diamond Island Formation off Highland Avenue, South Portland.

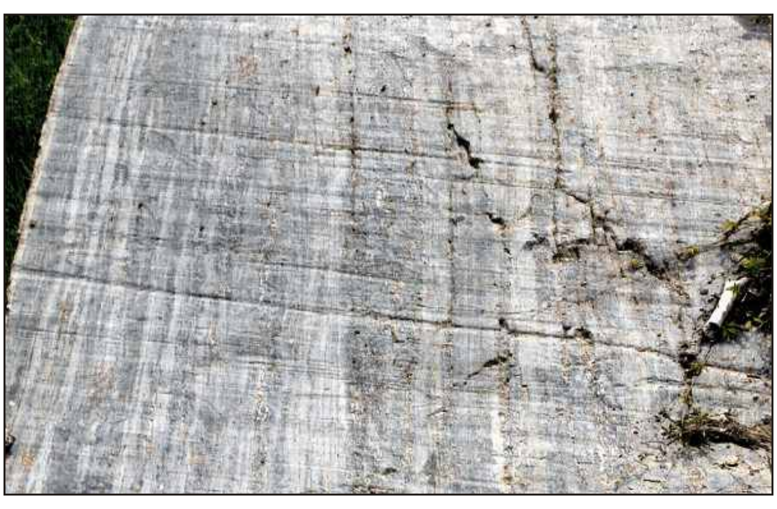

Photo 4. Highly sheared interlayered light gray calcareous phyllite and dark gray phyllite of the Eliot Formation, exit 7A area of the Maine Turnpike, South Portland. Glacially scoured surface of the exposure shows well-preserved glacial striations of the last episode of glaciation, approximately 14,000 years ago.

Photo 5. Exposure of sheared Eliot Formation between Fore River and Brighton Avenue, Portland. These rocks are of intermediate grade of metamorphism in which green amphibole and epidote are present.

Photo 6. Exposure of the Berwick Formation, injected by granite and pegmatite, in the Morrills Corner area of Portland.

Photo 7. Close-up view of typical Berwick rock type at same locality as Photo 6. Purplish gray bands have quartz, plagioclase feldspar, and biotite. Green bands (originally calcareous beds) have quartz, feldspar, diopside, hornblende, and epidote.

Photo 8. Blue Rock quarry between Westbrook and Portland. Biotite granofels of the Berwick Formation is quarried here for crushed rock aggregate. The Maine Turnpike is just out of sight on the left side of the photograph.

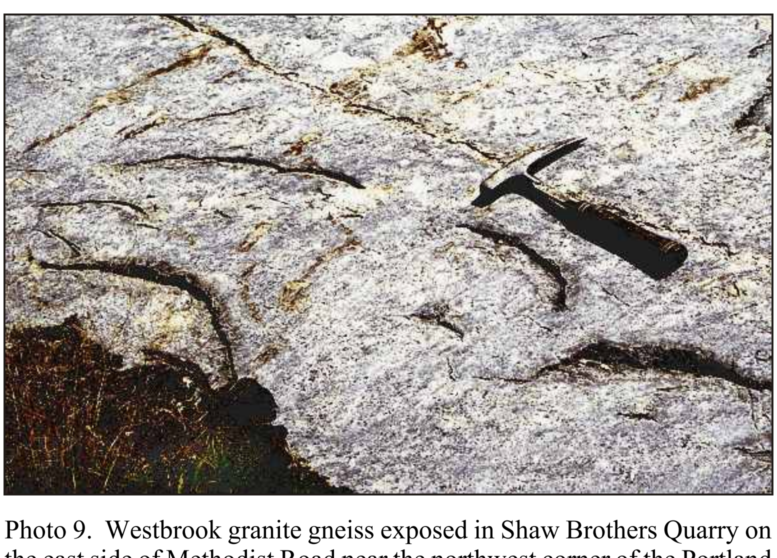

Photo 9. Westbrook granite gneiss exposed in Shaw Brothers Quarry on the east side of Methodist Road near the northwest corner of the Portland West quadrangle. Note the well-developed glacially produced crescentic gouges.

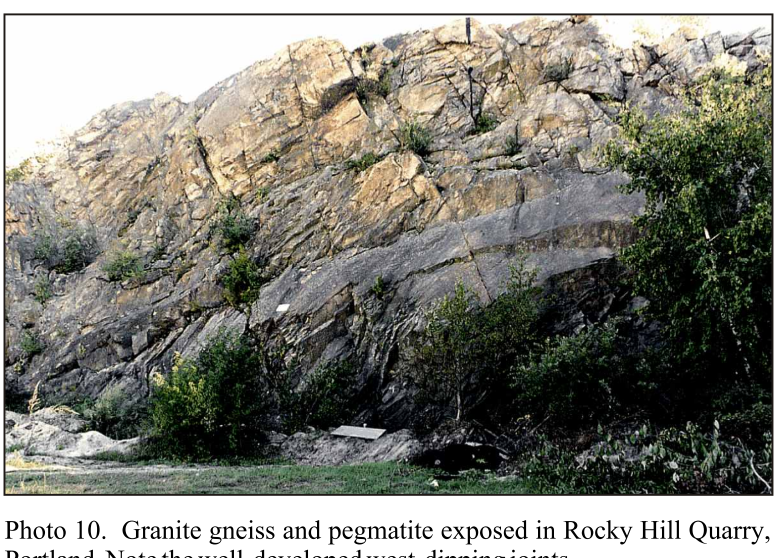

Photo 10. Granite gneiss and pegmatite exposed in Rocky Hill Quarry, Portland. Note the well-developed west-dipping joints.

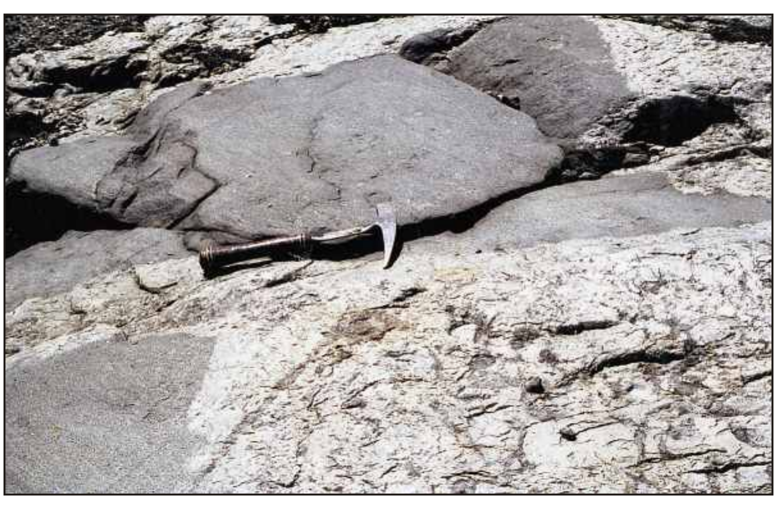

Photo 11. Cross-cutting dike of granitic pegmatite cutting granodiorite of the Westbrook pluton, same locality as Photo 9.

Photo 12. Highly sheared rocks of the Eliot Formation near Exit 7A, Maine Turnpike. Asymmetric lens-shaped phyllite in center of photo indicates a component of right-lateral shearing associated with deep-seated faulting of the Norumbega fault zone in Late Carboniferous to Permian time.